

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
22 November 2001 (22.11.2001)

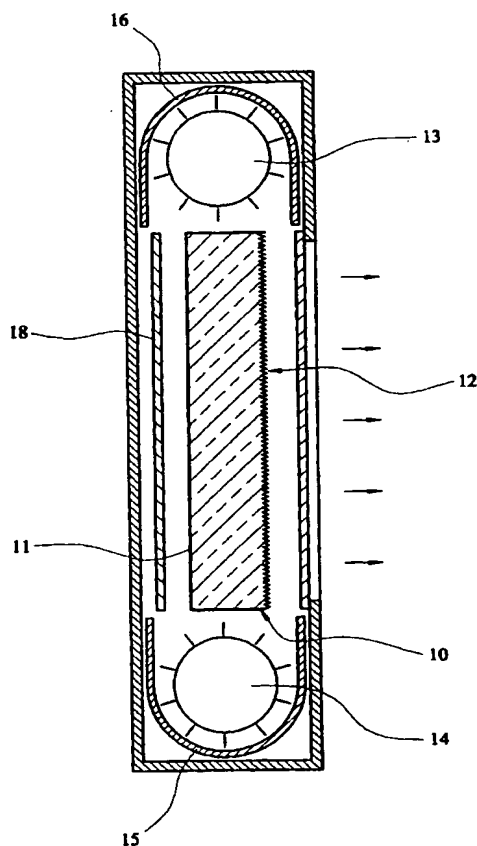
PCT

(10) International Publication Number
WO 01/88432 A1

- (51) International Patent Classification⁷: **F21V 8/00** (72) Inventor; and
(75) Inventor/Applicant (*for US only*): **ALLINSON, Heather**
(21) International Application Number: **PCT/GB01/01973** [GB/GB]; 71 Salutation Road, Darlington DL3 8JW (GB).
(22) International Filing Date: **4 May 2001 (04.05.2001)** (74) Agents: **WALSH, David, Patrick et al.**; Appleyard Lees,
15 Clare Road, Halifax HX1 2HY (GB).
(25) Filing Language: **English** (81) Designated States (*national*): AE, AG, AL, AM, AT, AU,
AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU,
(26) Publication Language: **English** CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM,
HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK,
(30) Priority Data: LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX,
0012003.0 19 May 2000 (19.05.2000) GB MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL,
0015401.3 24 June 2000 (24.06.2000) GB TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.
(71) Applicant (*for all designated States except US*): **INEOS** (84) Designated States (*regional*): ARIPO patent (GH, GM,
ACRYLICS UK LIMITED [GB/GB]; 1st floor, Queens KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian
Gate, 15-16 Queens Terrace, Southampton, Hampshire patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European
S014 3BP (GB). patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE,

[Continued on next page]

(54) Title: **EDGE LIT ILLUMINATION DEVICES**



(57) Abstract: An edge lit illumination device is described. The device has at least one light source (13, 14) and a light transmission element (10) having at least one light output surface (12) and at least one light ingress edge substantially perpendicular to said surface (12). The light source (13, 14) is located adjacent to the light ingress edge so that light from the light source (13, 14) enters the transmission element (10) via the said edge and propagates through the element (12). The light output surface (12) is uniformly roughened across the output surface. The roughening is sufficiently fine to give an average Ra value across the surface of less than 1.0 $\mu\text{m/mm}$ thickness of the element or drop-off of light output across the surface of less than 5000 lux.

WO 01/88432 A1

WO 01/88432 A1



IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Published:

— with international search report

EDGE LIT ILLUMINATION DEVICES

The present invention relates to edge lit illumination devices and, in particular, edge lit illumination devices with roughened surfaces. Numerous applications for edge lit illumination devices are known. Edge lit illumination devices include illuminated display units or signs, lap top computer screens, LCD display back lighting, road signs, street furniture, advertising units, illuminated shelving, internal lighting of appliances such as illumination of the sides, back, or top of fridge units including display fridges, wine chillers/coolers. Edge lit illumination devices also include appliance fronts and fascias such as dial and control knob panels.

Edge lit devices utilise numerous light sources including planar light sources and curved light sources.

Generally, the illumination device includes a light source located adjacent to a light transmission element. The light transmission element includes a light output surface and at least one light ingress edge adjacent to the light source so that light from the light source enters the transmission element via the said edge to propagate through the element.

Many attempts have been made at modifying the roughening at the surface of the light transmission element so that the light propagating through the transmission element escapes through the surface. The light transmission element typically acts as a display window with the material to be displayed located behind, in front of, or on the actual surface itself.

For instance, DE 2356947 discusses the possibility of providing what is said to be finely roughened or frosted parts of the surface. However, the fine roughening is employed so as to avoid the possibility of coarse roughening impairing the transparency of the unit. The light output of this material is discussed in DE 3223706 and is said to be insufficiently uniform across the sheet so that increasing density of roughness with increasing distance from the light source is required.

DE3223706 discloses the benefit of increasing the density of roughening with increasing distance from the light source in order to increase output which naturally falls across the plate.

US 4385343 discloses an edge lit product, including acrylic material as the light transmitting body, which has both surfaces of the light transmitting body roughened. The distribution of the light on the light egress face surface can be attained by selecting an appropriate angular relation between the backing material reflecting surface and the surface of the sheet when they are spaced apart or by tapering of the light transmitting body which is convergent in the direction away from the light ingress edge surface. Plane parallel faces are also shown. The document indicates that the plane parallel faces arrangement of figure 7 is only adequate if the edge lit sign is relatively small. The method of application of the roughness is by abrasion using a flapper wheel with strips of sandpaper attached or by cutting the surface of the transparent plate. The cutting device is said to give a cut into the surface of the transparent material between 5/1000 of an inch and 100/1000 of an inch. The document indicates that there is a falling away of light with distance from the light source and that the solution to this problem is to vary the thickness or to converge the

plate with increasing distance. It also discusses the possibility of angling the plate if spaced from the light source.

5 US 3497981 solves the problem of light egress in a similar manner to US 4385343. The manner by which the roughness is applied to the rod includes chemical etching as well as sandblasting. The document discloses that it is necessary to use differential etching in order to have sufficient
10 light output in anything other than small letters.

US 5625968 does not relate to surface roughness but the application of a dot matrix pattern to allow egress of light from within the sheet. The dot matrix pattern is
15 preferably of increasing density towards the centre of the sheet and away from the light source.

GB 2161309A again solves the problem of light egress by increasing the coarseness of the roughness away from the
20 light source.

GB 2211012 discloses an edge illuminated display aid which includes the display element 63 of transparent material to produce a scattering, which treatment is intentionally
25 increased in severity or optical density with increasing distance from the light source 62.

GB 2164138 relates to a light diffusing device and an illumination apparatus employing the light diffusing
30 device. The diffusing layers are provided with thicknesses which are different from each other or, otherwise, arranged to have a density which varies along the device, thereby illuminating a desired object uniformly as a whole.

35

UK 2196100 discloses a light diffusing device which includes a light diffusion layer 3 but also a light

reflecting film 7 which decreases reflectivity with increasing distance from the light source b, c and thereby provides an even distribution of light from the light diffusion layer 3 on to the light diffusing plate 6. The document discusses the problem with edge lit frosted glass plates or opal glass plates in that they fail to evenly illuminate the entire surface of the light diffusing plate.

10 US 4059916 relates to edge lit products with a roughened rear surface and a reflecting layer generally against the rear surface. The effect of the roughened surface is to increase the light reflected through the front surface. The roughening is described as grooves and ridges across
15 the surface. The document discusses the advantages in thinning the sheet with increasing distance from the light source.

PCT WO84/04838 discloses a display device whereby both the
20 upper and lower surfaces may be roughened by nailing, blasting or stamping. The document also addresses the problem of decreasing light with increasing distance from the light source and this problem is solved by using a convex rear surface so that the plate is progressively
25 thinner with increasing distance from the light source.

EP 0561329 This document discloses an edge lit light display device having light sources along all four side edges. The document also envisages the possibility that
30 the density of the roughness of the dots applied to the surface may be uniform in one direction. The document teaches that it is necessary to have variation in density in the other direction in order to have uniform brightness.

35

US 5649754 discloses a combination of two types of roughening. It also discloses the possibility that there

is an underlying uniform roughness. To solve the problem of achieving uniform brightness across the surface, a further layer is applied to the uniform layer. The document discloses that the roughness may be applied by sandblasting and is thus relatively coarse.

The above documents show a clear trend towards the provision of either varying density surface features to provide uniform brightness across the light output surface or varying transmission plate thickness to maintain light output. Such techniques are difficult and expensive to apply to the surface or the sheet. Furthermore, each application requires its own optical characteristics and, therefore, in the case of density variations, it is necessary to specifically vary the roughness density in relation to specific products. Accordingly, each product is typically customised thus further increasing expense.

According to a first aspect of the present invention there is provided an edge lit illumination device comprising at least one light source; a light transmission element having at least one light output surface and at least one light ingress edge substantially perpendicular to said surface, the light source being located adjacent to said light ingress edge so that light from the light source enters the transmission element via the said edge and propagates through the element, the said at least one light output surface being uniformly roughened across the output surface, wherein the roughening is sufficiently fine to give an average Ra value across the surface of less than $1.0\mu\text{m/mm}$ thickness of the element.

According to a second aspect of the present invention there is provided an edge lit illumination device comprising at least one light source;

a light transmission element having at least one light
5 output surface and at least one light ingress edge substantially perpendicular to said surface, the light source being located adjacent to said light ingress edge so that light from the light source enters the transmission element via the said edge and propagates
10 through the element, the said at least one light output surface being uniformly roughened across the output surface, wherein the roughening is sufficiently fine to give drop-off of light output across the surface of less than 5000 lux.

15

Preferably, in relation to the second aspect the average Ra value across the surface is less than 1.0 $\mu\text{m/mm}$ thickness of the element.

20 By uniformly roughened is meant that the level of roughness does not generally increase or decrease with increasing distance from the light source. However, there may be small localised variance in the roughness due to the inherent variance in the process or the means by which
25 roughness is applied. However, such variance would be random and would exist across the whole surface and would not create any particular trend across the whole of the output surface.

30 Preferably, the transmission element maintains substantially uniform thickness with increasing distance from the light source.

Typically, the average Ra value across the output surface of the transmission element is less than $0.75\mu\text{m}/\text{mm}$ thickness, more preferably less than $0.40\mu\text{m}/\text{mm}$ thickness, most preferably less than $0.30\mu\text{m}/\text{mm}$ thickness. Especially preferred average Ra values for rough surfaces on transmission elements are less than $0.15\mu\text{m}/\text{mm}$.

Preferably, the average Ra value across the surface of the transmission element is found within the range $0.01\text{--}1.0\mu\text{m}/\text{mm}$ thickness of element, more preferably $0.02\text{--}0.75\mu\text{m}/\text{mm}$ thickness of element, most preferably $0.02\text{--}0.40\mu\text{m}/\text{mm}$ thickness of element. Especially preferred is an average Ra value in the range $0.05\text{--}0.30\mu\text{m}/\text{mm}$.

For example, on a 10mm thick sheet the average Ra value may be $1.8\mu\text{m}$, whereas equivalent uniformity of output with a 5mm thick sheet may be obtained with an average Ra value of $0.9\mu\text{m}$. In both cases, the average Ra value would be $0.18\mu\text{m}/\text{mm}$ thickness of sheet. Similarly, if more than one surface is roughened the Ra values may be additive so that a roughness of $0.9\mu\text{m}$ on the upper and lower surface of a 10mm sheet would also give an average Ra value of $0.18\mu\text{m}/\text{mm}$ thickness of sheet.

Preferably, roughening is applied to one or more light output surface(s). However, in addition to roughening of a front surface roughening of a back surface with or without a reflector to redirect light to an output surface is also envisaged.

30

Localised fluctuation in the surface Ra value may be between $0.01\mu\text{m}\text{--}1.0\mu\text{m}$, preferably, between $0.05\mu\text{m}\text{--}1.0\mu\text{m}$, more preferably $0.1\mu\text{m}\text{--}0.8\mu\text{m}$, most preferably, $0.2\mu\text{m}\text{--}0.6\mu\text{m}$.

For example, the surface roughness may be between 0.9-1.3 μ m for a Type A surface having 5-10mm thickness. However, if the average surface roughness is 1.1 μ m, this will be so across the surface and any fluctuation will be substantially random and will not create a defined variation in density across the surface.

It is possible to apply roughness to both a first light output surface and a second light output surface which may be spaced from and opposite the first on the opposed side of the transmission element and, in such cases, the Ra value/mm would be taken to be the sum of the two average Ra values divided by the overall thickness of the sheet.

As mentioned above, the invention may be put into effect by applying roughening on one surface of the transmission element or, where the element is a sheet of material, on both surfaces thereof. In addition, a plurality of sheets may be in superposed relationship and roughening may be applied to the outer faces of the superposed sheets, the inner mating faces or any combination of inner faces and outer faces.

Preferably, the drop-off of light output across the surface is less than 4000 lux, more preferably, less than 3000 lux, most preferably less than 2000 lux.

Preferably, the initial drop-off measurement is taken from a position of at least 50mm in from the edge of the element, more preferably, at least 100mm in from the edge, most preferably at least 150mm in from the edge of the element. The final reading may be taken from equivalent points in relation to the opposite edge of the element.

However, the drop-off is the measured fall in light output from the initial measurement to the output low-point across the sheet.

5 In a single edge lit product, this low point will be where the final measurement is made at the opposite edge of the element but in a multiple edge lit product, the low point will typically be that point most distant from the edges where the light sources are formed and this will typically
10 be in the middle of the element, assuming equivalent output edge lights. It is envisaged that the drop-off may be negligible and may also be negative so that an increase in light output is found across the sheet with increasing distance from the light source.

15

Preferably, the transmission element is a sheet of, preferably, transparent material although optionally, translucent material.

20 Typically, the transmission element is a rectangular sheet which may be square. However, the sheet may be of any shape, for example round, square, rectangular, triangular, cylindrical, irregular.

25 The sheet may be made from any suitable plastic material, preferably acrylic material is used. Preferred materials may be selected from polymethyl methacrylate, polyethyl methacrylate, polypropyl methacrylate, polybutyl methacrylate, polyglycidyl methacrylate, polyisobornyl
30 methacrylate, polycyclohexyl methacrylate either as homopolymers or as copolymers of at least one preceding polymer including such copolymers containing a minor proportion of another monomer selected from at least one

C₁₋₄ alkyl acrylate. Preferably, polymethyl methacrylate is used.

Preferably, the transmission element is less than 3000mm
5 in the dimension perpendicular to or away from the light source edge, more preferably, less than 2000mm in this width dimension, most preferably, less than 1500mm in this width dimension.

10 Preferably, the transmission element is less than 100mm in thickness, more preferably, less than 50mm in thickness most preferably, less than 30mm in thickness.

Typically, the range of thicknesses of the transmission
15 element is 1-100mm, more preferably, 1-50mm, most preferably, 3-25mm.

Methods of making the transmission element include cast
polymerisation, moulding, extrusion and embossing and
20 coextrusion.

The embossing of an extrusion sheet may take place during
or after manufacture. Roughening on the surface layer of
the co-extruded material may be effected by suitable
25 matting or gloss-control agents. Suitable matting or gloss-control agents to cause sufficiently fine roughening on the surface layer of co-extruded material are known in the art of co-extruded materials. Suitably fine frosting
of glass to produce the level of roughness required during
30 casting is available and known in the art of glass manufacture. An example of such casting glass is available from Pilkington UK plc.

Preferably, the transmission element corresponds to the length of the light source in the dimension parallel with the light source or along the light source edge of the element. The transmission element may also be marginally longer than the light source in this dimension. Preferably, the light source is elongate.

Typically, the transmission element is between 100mm and 3000mm long in the dimension perpendicular to or away from the light source edge, more preferably between 200mm and 2000mm long in this dimension, most preferably between 300mm and 1500mm long in this dimension. Especially preferred is a width in this dimension of between 400 and 1200mm.

15

Usage for the invention includes illuminated display units or signs including lap top computer displays and LCD display back lighting, road signs, street furniture, advertising units, appliance fronts and fascias, such as dial and control knob panels, internal lighting of appliances such as illumination of sides, back and top of fridge units, display fridges, wine chillers and coolers.

The light sources may be straight or curved as may the edges of the transmission element. Preferably, the light sources are planar. Any suitable light source may be used but suitable light sources include fluorescent tubes, cold cathode tubes, neon tubes, LED's conventional and organic, fibreoptics and light bulbs.

30

Preferably, fluorescent tubing is used. The diameter of the fluorescent tube may vary from typically 6mm, commonly referred to as T2, to 25mm. The distance from the edge of

the light transmitting panel to the crest of the tube is preferably between 1 and 2mm. In an alternative embodiment the fluorescent tube is an aperture tube. This type of tube has coated on the inside wall of the glass a reflective coating with a fluorescent coating on top of it. The aperture is a part of this tube, for example 30° of the 360° around the inside of the tube, with no coating. This opening runs the length of the tube and is arranged so it is directing light from the light source at the edge of the light transmitting sheet. A reflector is typically positioned behind each fluorescent tube and may be any material capable of reflecting light, for example mirrored aluminium. Preferably, the light transmitting sheet is in a fixed relationship to the light source.

15

By way of illustration only, the invention will now be described with reference to the accompanying, non-limiting examples and with reference to figures 1-5 in which:-

20 Figure 1 shows a comparison of light output vs position across the sign for single and double sided type B and single sided type A roughened surfaces.

Figure 2 shows a comparison of light output vs position across the sign for double sided type A and Prismex.

25 Figure 3 shows a comparison of light output vs position across the sign for double and single sided type A and single sided type B.

Figure 4 shows a comparison of light output vs position across the sign for double sided type A and multiple single sided type A;

30

Figure 5 shows a comparison of light output vs position across the sign for co-extruded type A and Prismex; and

Figure 6 shows an edge lit display using a sheet in accordance with the invention.

The surface texture of the roughened surfaces has been defined by means of a Ra parameter. ISO 4287 and 4288 describe the recommended procedures for determining Ra and other statistical parameters. Measurements were made using a TALISURF meter. For convenience, those surfaces with Ra in the range 0.9-1.3 are denoted as Type A and those surfaces with an Ra in the range 1.3-1.8 are denoted as Type B. Gloss measurements were made using an Erichson mini glossmeter 507-M (85e). The equivalent gloss values for Type A surfaces are 24-30% and for Type B surfaces 14-22%. The roughness can be considered as a higher frequency surface effect superimposed on top of waviness and form. The roughness is usually described by Ra or similar parameters which is within a 10 μ m vertical range. The afore mentioned ISO standards describe the recommended sampling links and cut off values for making measurements. For instance, for a periodic profile of 4mm (upper limit of the range), the cut off value is 8mm and sample length is 40mm. This is for an Ra value of around 10 μ m.

Experimental details

25

The examples use a rectangular sheet of thickness range 3mm - 25mm made from clear cast polymethylmethacrylate which has one or two frosted or matt surfaces. The frosted surface was made by cast polymerisation against an etched glass plate. The frosted surface is characterised by gloss measurements and by surface roughness measurements.

Gloss measurements were made using an Erichsen Mini Glossmeter 507-M measuring the percentage of reflected light at an angle of 85 degrees. For Type B gloss measurements were in the range 14 - 22%, for Type A this
5 increases to 24 - 30%.

Roughness measurements (R_a , microns) were made using a Surtronic 3P Talisurf meter supplied by Rank-Taylor-Hobson. This is calibrated against a reference tile before
10 use. The reference used is a rough metal tileplate (240 micro inches) with the meter in calibration mode. The R_a of the sample is measured directly. For the samples used in the examples, Type B has an R_a value in the range 1.3 - 1.8 μ , whilst Type A has an R_a of 0.9 - 1.3 μ . (The range of
15 values is due to variability in the roughness of glass used for casting and also due to wear of the glasses during repeated use through their lifetime.

All roughened surface panels were made from acrylic cast
20 against frosted glass, two different degrees of frosting being used to achieve Type A and Type B finishes. The chosen panel is placed in a framework that forms the sign, light sources are placed adjacent to the input edge of the panel. In the examples two light sources have been used on
25 opposing edges of the panel.

Light output measurements are made by placing a RS Digital Lightmeter (RS 180-7133) on the surface of the sign. An array of points are measured on the surface, and points
30 equi-distant from a tube are averaged. These averaged values are displayed graphically in figure 1-5. Typically the light output with distance from one or both of the light input edges is recorded.

The samples were compared with Prismex from Ineos Acrylics UK Ltd, which is a successful product with a dot matrix printed surface to achieve improved light output.

5

Examples

1. Type B single sided and double sided v Type A single sided, A2 sign, 2ft apertures, 5mm sheet (Figure 1)

10

Acrylic Panel dimensions: 635 x 455mm x 5mm thick
Light source: Philips TLD fluorescent aperture tube, 18 watts, colour rendering value of 85, colour temperature of 6500K, tube diameter 25mm.

15

2. Type A v Prismex, approximately A1 sized, 10mm (Figure 2)

Acrylic Panel dimensions: 885 x 635mm x 10mm thick
Light source: 2 x Philips TLD aperture fluorescent tube, 30watts, colour rendering 85, colour temperature 6500K.

The Type A samples were produced from cast Type A sheet. The Prismex samples were made by screen printing an array of white dots onto opposing surfaces of clear cast acrylic sheet.

25

3. Larger area sign: Type B single v Type A double v Type A single (Figure 3)

30

Acrylic Panel size: 945mm x 865mm x 10mm thick
Light source: 2 x Philips TLD aperture tubes, 30W, etc.

This example shows that it is important to choose the correct surface roughness for the thickness of panel being used, but also the correct roughness for the panel dimension (length of panel between the two tubes in this case). In comparison with example 2 above where the optimal panel was a Type A surface on both sides, here a Type A surface on just one side is better when a longer path length is used. However the trends are the same, namely that the light output characteristics improve as the overall roughness of the panel is reduced.

3ft sign using various rough surface panels: experimental details as described previously.

4. 1 x 10mm double Type A v 2 x 5mm single Type A (Figure 4)

Panel dimension and light source as for example 2.

This example illustrates the point that multiple superposed thinner panels can be used to create the same output as a single thicker panel as long as the surface roughnesses of each are chosen appropriately. Here a 10mm panel with two Type A surfaces is compared with 2 panels 5mm thick with a single side of Type A on each. In the example the rough surfaces are on the outermost faces of the combination, however there is no measured difference when the rough surfaces are in other orientations.

Various data for Type A surfaces made by casting have been described above. There are other methods of creating a rough surface. These include coextrusion and extrusion then embossing. Detailed here is an example of a

coextruded Type A sheet used for edge lighting, where the Type A sheet has a single rough surface.

5

5. 1 x 5mm Co-Extruded Type A vs Prismex (Figure 5)

A2 sized sign, panel dimensions: 635 x 455mm x 5mm thick, coextruded Type A (Co-Extruded Type A).
Light source: 2 x Philips TLD fluorescent aperture tube, 18W.

Specific embodiments of the invention will now be further described with reference to the accompanying drawing (Figure 6) which is a sectional view through an illuminated display system according to the invention and is illustrated to show an embodiment of the invention in use.

20

In Figure 6 the light transmitting sheet (10) is a 945 x 865 x 10mm clear cast polymethylmethacrylate (PMMA) sheet as exemplified by a type A surface single side which is untreated on the rear surface (11) but has a rough surface formed on its light output surface (12). The light sources are Philips TLD 30W/865 FA30 fluorescent tubes (13, 14) which both have a power output of 30 Watts, a colour rendering value (Ra) of 86, a colour temperature of 6500 Kelvin and a diameter of 25mm. These are each placed adjacent to an edge of the light transmitting sheet and surrounded by a mirrored aluminium reflector (15, 16). A further reflection sheet 18 is located adjacent to and parallel with the rear surface 11 to reflect light back

30

towards the output surface 12 (the reflection sheet is shown spaced for illustration purposes although, in use, it would usually abut against the rear surface of the transmission sheet).

5

The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this
10 specification, and the contents of all such papers and documents are incorporated herein by reference.

All of the features disclosed in this specification (including any accompanying claims, abstract and
15 drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

20 Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each
25 feature disclosed is one example only of a generic series of equivalent or similar features.

The invention is not restricted to the details of the foregoing embodiment(s). The invention extend to any novel
30 one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel

combination, of the steps of any method or process so disclosed.

CLAIMS

1. An edge lit illumination device comprising at least one light source;
5 a light transmission element having at least one light output surface and at least one light ingress edge substantially perpendicular to said surface, the light source being located adjacent to said light ingress edge so that light from the light source enters the
10 transmission element via the said edge and propagates through the element, the said at least one light output surface being uniformly roughened across the output surface, wherein the roughening is sufficiently fine to give an average Ra value across the surface of
15 less than $1.0\mu\text{m}/\text{mm}$ thickness of the element.
2. An edge lit illumination device comprising at least one light source;
a light transmission element having at least one light output surface and at least one light ingress edge
20 substantially perpendicular to said surface, the light source being located adjacent to said light ingress edge so that light from the light source enters the transmission element via the said edge and propagates through the element, the said at least one light
25 output surface being uniformly roughened across the output surface, wherein the roughening is sufficiently fine to give drop-off of light output across the surface of less than 5000 lux.
3. An edge lit illumination device according to claim 2,
30 wherein the average Ra value across the surface is less than $1.0\mu\text{m}/\text{mm}$ thickness of the element.
4. An edge lit illumination device according to any of claims 1-3, wherein the transmission element maintains

substantially uniform thickness with increasing distance from the light source.

- 5 5. An edge lit illumination device according to any of claims 1-4, wherein the average Ra value across the output surface of the transmission element is less than $0.75\mu\text{m}/\text{mm}$ thickness.
- 10 6. An edge lit illumination device according to any of claims 1-5, wherein the average Ra value across the surface of the transmission element is found within the range $0.01\text{-}1.0\mu\text{m}/\text{mm}$ thickness of element.
- 15 7. An edge lit illumination device according to any of claims 1-6, wherein roughness is applied to both a first light output surface and a second light output surface which may be spaced from and opposite the first on the opposed side of the transmission element and, in such cases, the Ra value/mm would be taken to be the sum of the two average Ra values divided by the overall thickness of the sheet.
- 20 8. An edge lit illumination device according to any of claims 1-6, wherein a plurality of sheets may be in superposed relationship and roughening may be applied to the outer faces of the superposed sheets, the inner mating faces or any combination of inner faces and outer faces.
- 25 9. An edge lit illumination device according to any of claims 1-8, wherein the drop-off of light output across the surface is less than 4000 lux.
- 30 10. An edge lit illumination device according to any of claims 1-9, wherein the transmission element is less than 3000mm in the dimension perpendicular to or away from the light source edge.

11. An edge lit illumination device according to any of claims 1-10, wherein the transmission element is less than 100mm in thickness.
12. An edge lit illumination device according to any of
5 claims 1-11, wherein methods of making the transmission element include cast polymerisation, moulding, extrusion and embossing and coextrusion.
13. An edge lit illumination device according to any of
10 claims 1-12, wherein roughening on the surface layer of the co-extruded material is effected by suitable matting or gloss-control agents.
14. An edge lit illumination device according to any of claims 1-13, wherein the transmission element is between 100mm and 3000mm long in the dimension
15 perpendicular to or away from the light source edge.
15. An edge lit illumination device as hereinbefore described.
16. An edge lit illumination device as hereinbefore described and with reference to figure 6.

-1/6-

Type B single sided and double sided v type A single sided,
A2 sign, 2ft aperture tubes, 5mm sheet

Type B v Type A

A2 sign, aperture tubes

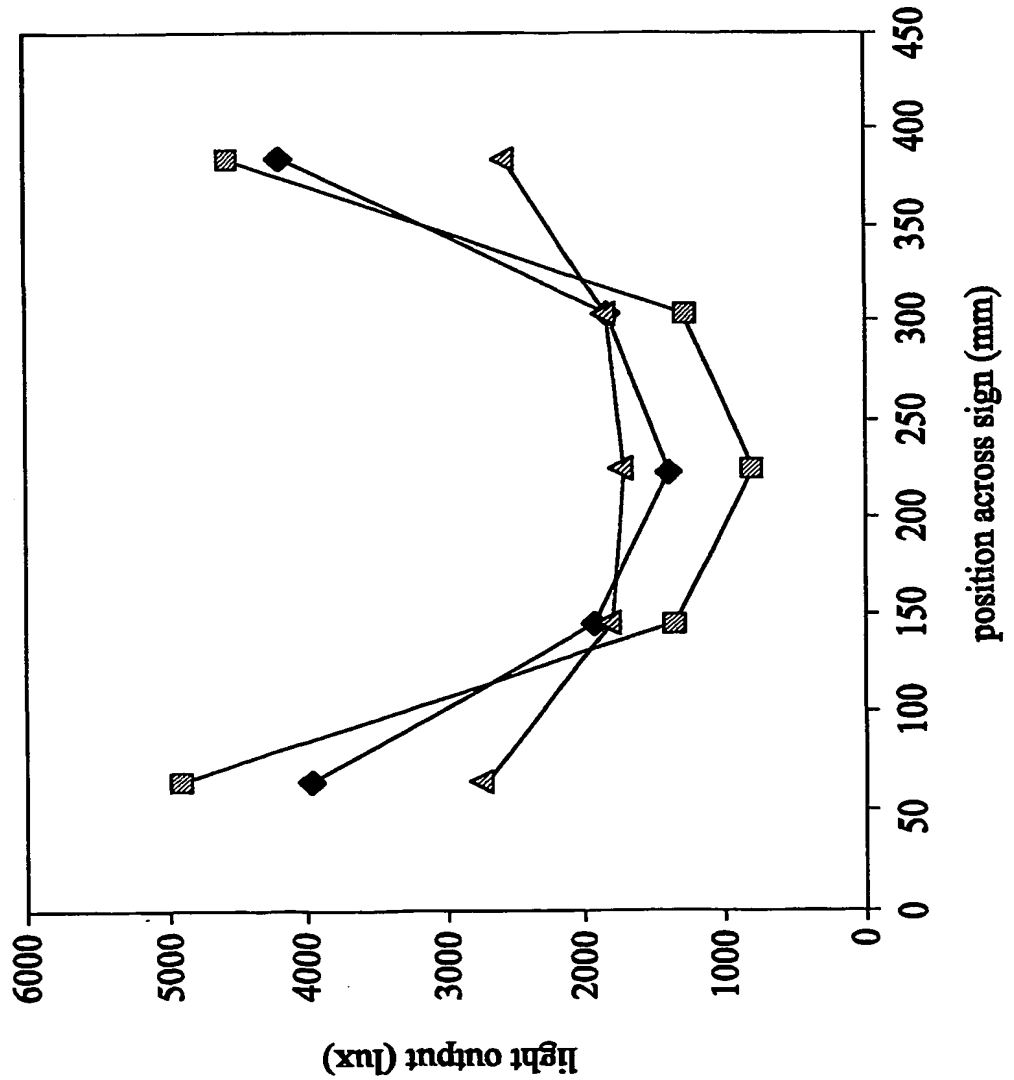


FIG. 1

-2/6-

Type A v Prismex, approximately A1 sized, 10mm thick

Roughened surface v Prismex
Philips aperture tubes

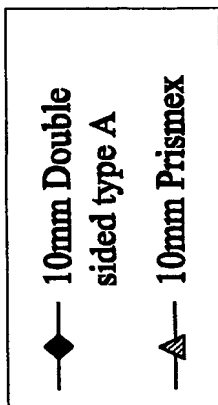
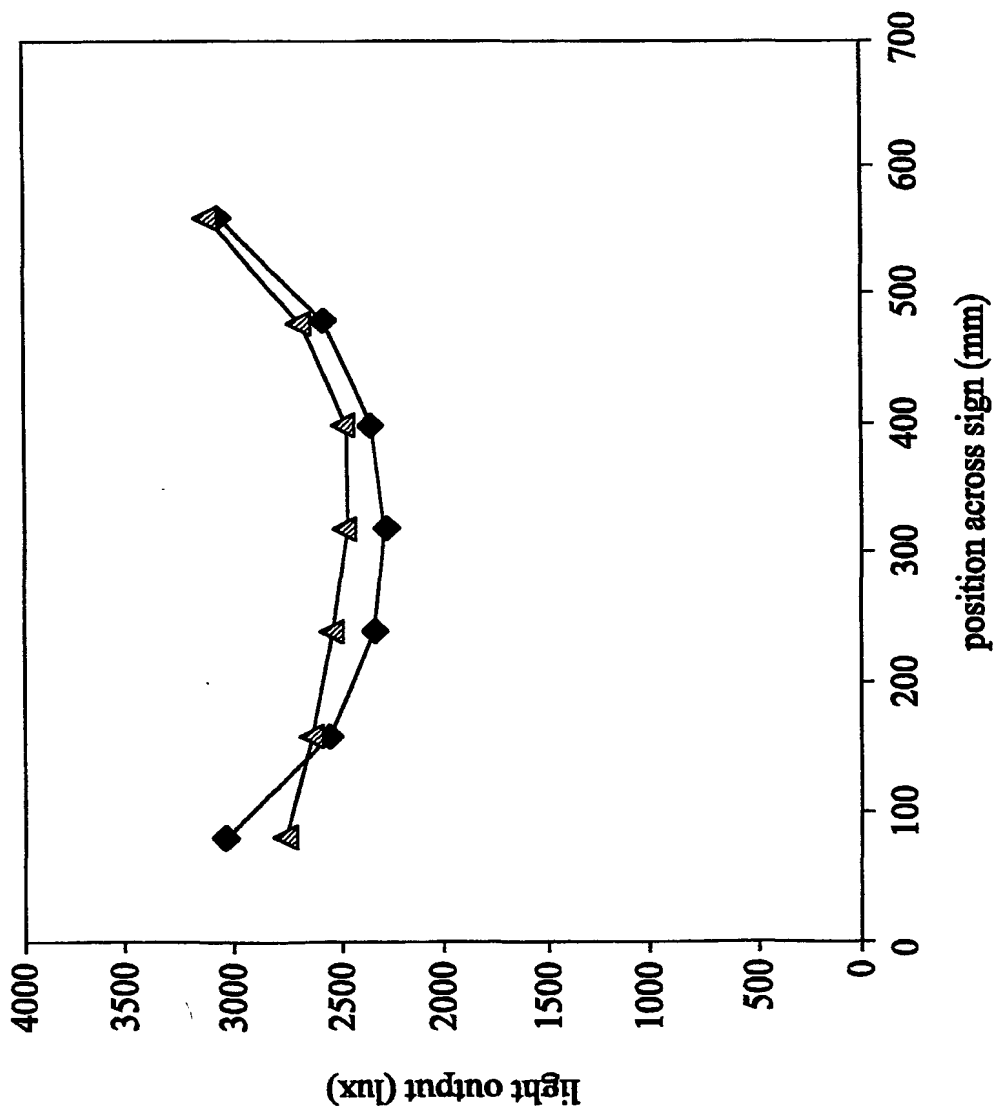


FIG. 2

-3/6-

Larger area sign: type B single v type A double v type A single sided

3 ft sign
Philips aperture tubes

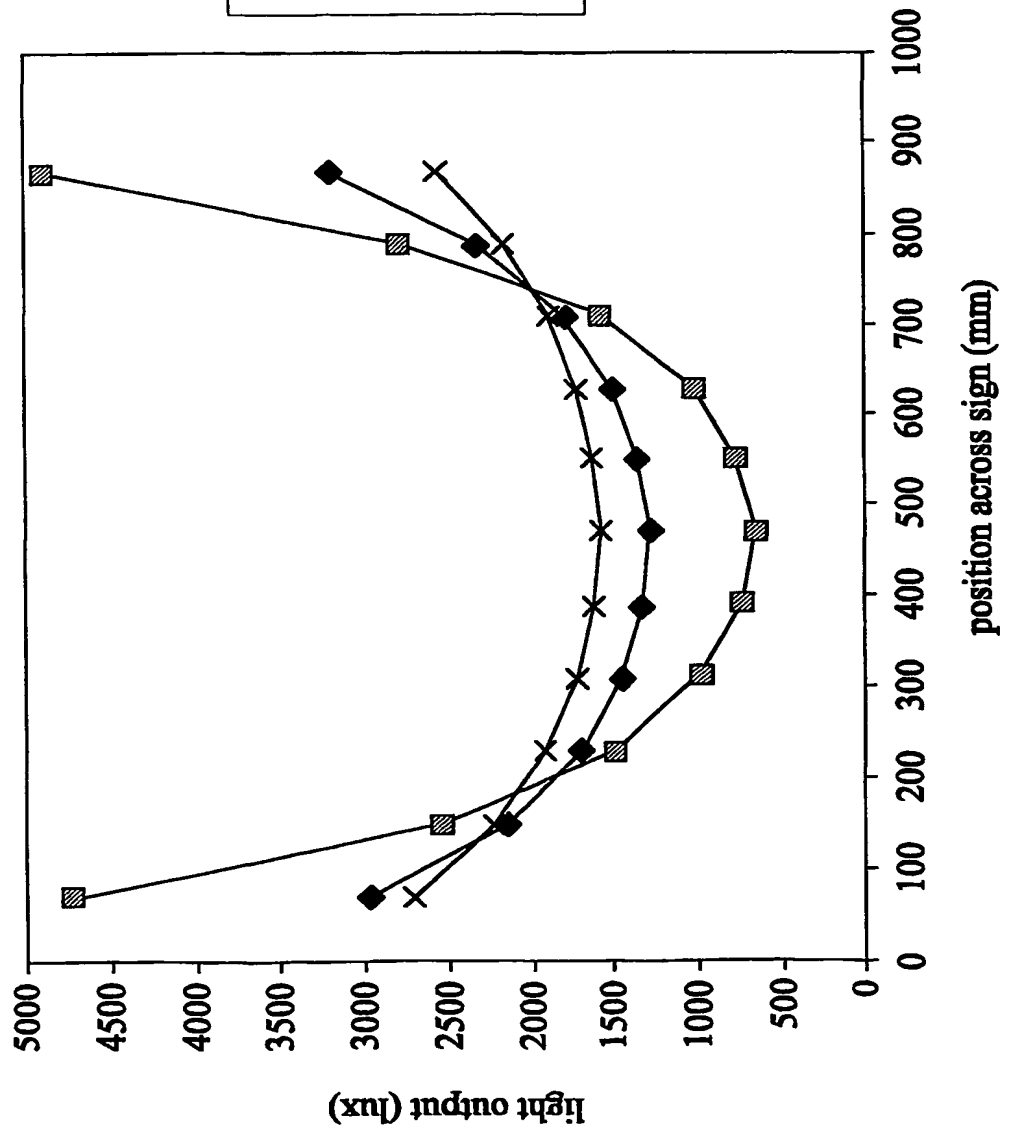


FIG. 3

4/6-

1 x 10mm double type A v 2 x 5mm single type A

Multiple panels v single panel
A1, aperture tubes

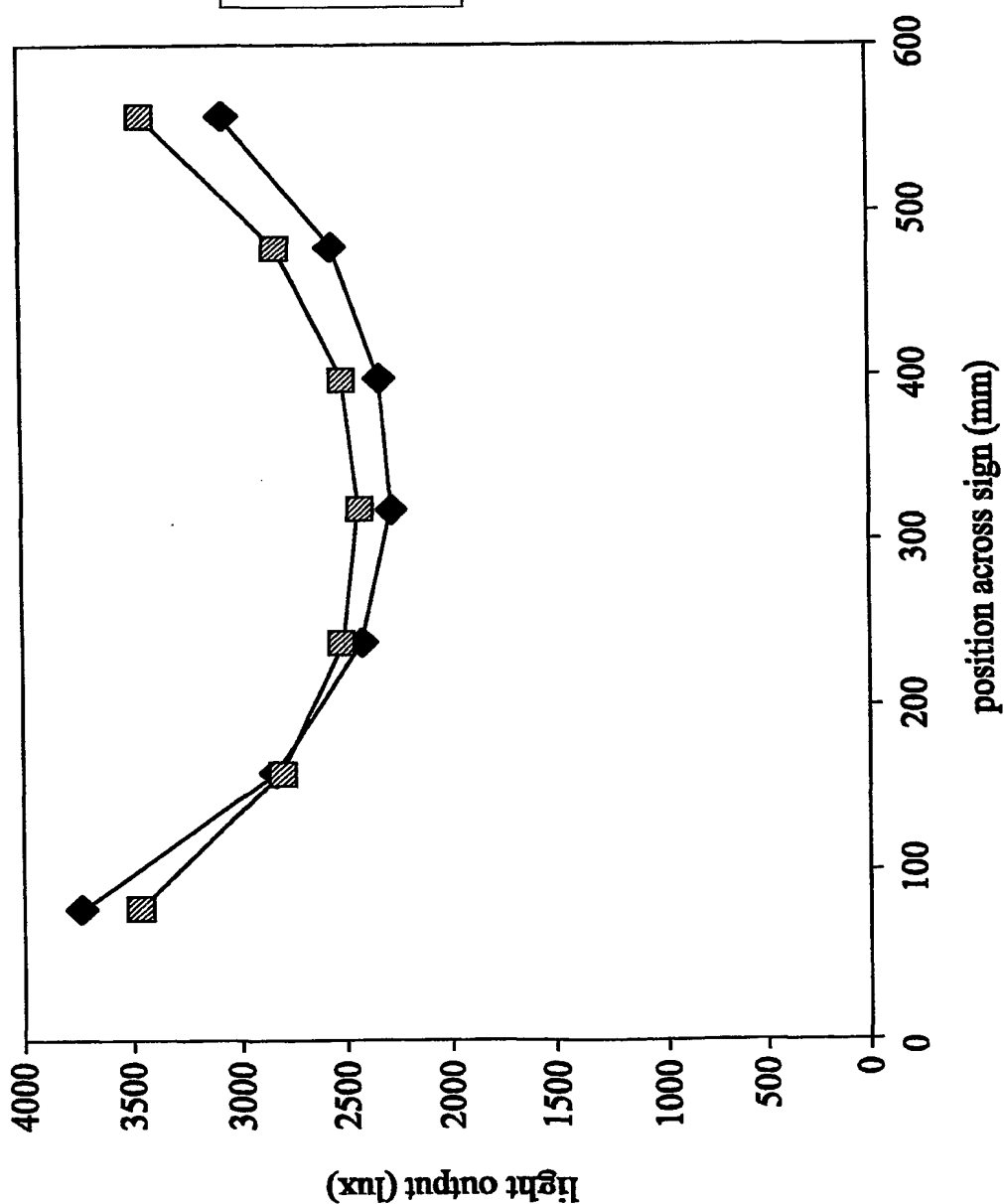


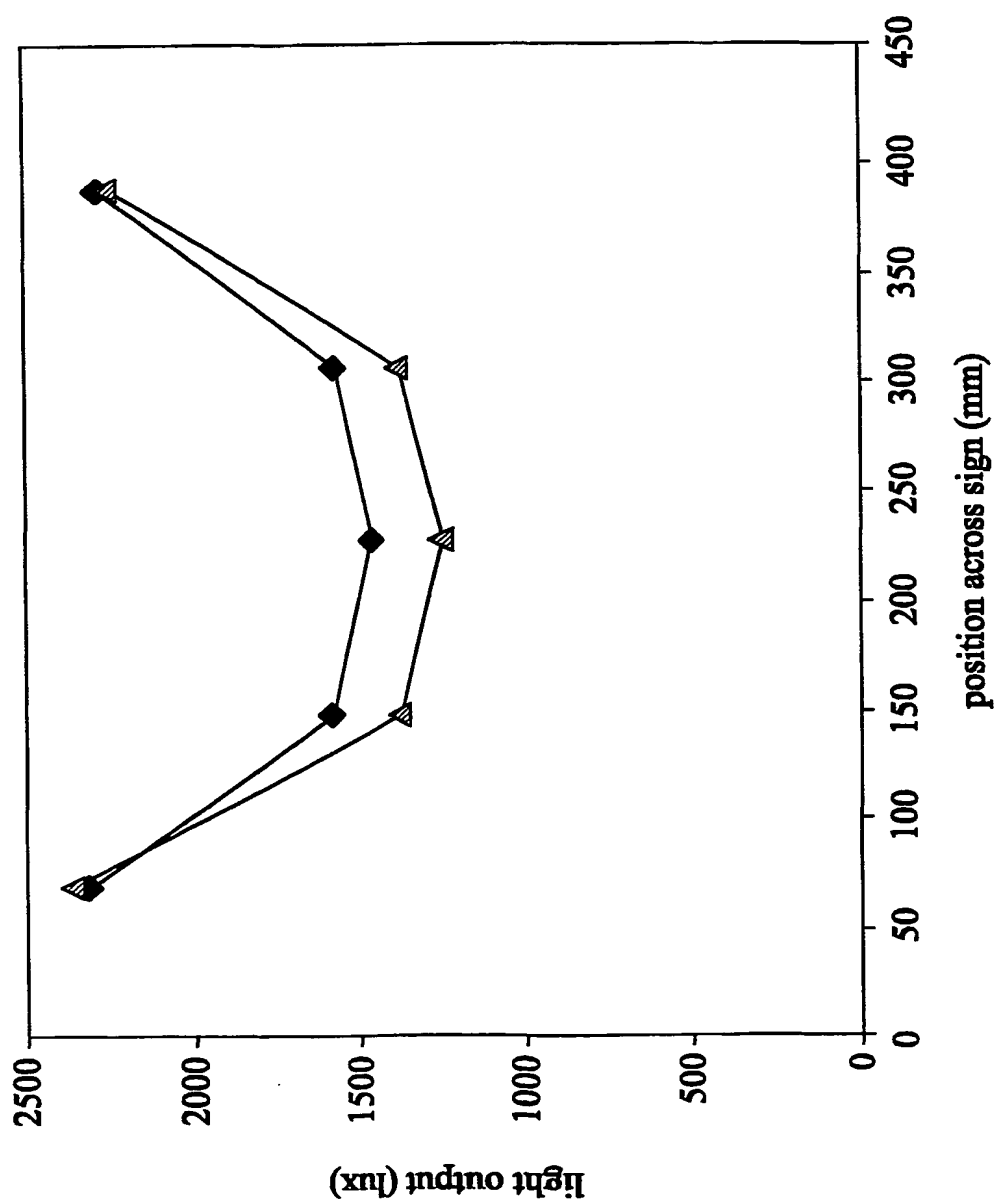
FIG. 4

-5/6-

FIG. 5

1 x 5mm Coextruded type A v Prismex

5mm Coex type A v 5mm Prismex
A2 sign, aperture tubes



-6/6-

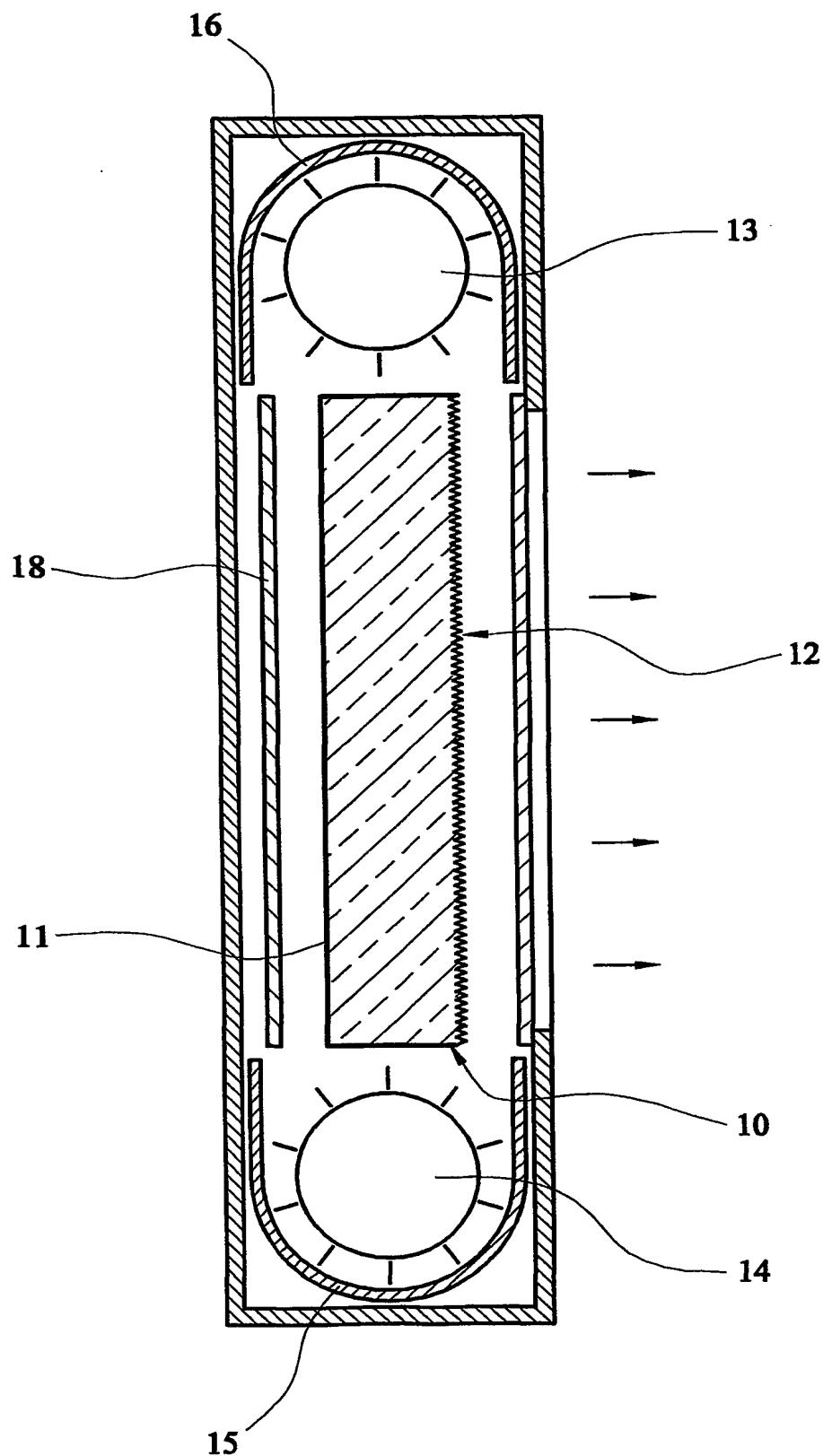


FIG. 6

INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 01/01973

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F21V8/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 F21V

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 649 754 A (I.MATSUMOTO) 22 July 1997 (1997-07-22) cited in the application abstract; figures 1-13	1,2
A	EP 0 561 329 A (ENPLAS) 22 September 1993 (1993-09-22) cited in the application abstract; figure 9	1,2
A	EP 0 504 910 A (TOSOH) 23 September 1992 (1992-09-23) abstract; claims 1-7; figures 1-4	1,2

☐ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

* Special categories of cited documents:

A document defining the general state of the art which is not considered to be of particular relevance

E earlier document but published on or after the international filing date

L document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

O document referring to an oral disclosure, use, exhibition or other means

P document published prior to the international filing date but later than the priority date claimed

T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

G document member of the same patent family

Date of the actual completion of the international search

28 June 2001

Date of mailing of the international search report

11/07/2001

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Malic, K

INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 01/01973

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5649754 A	22-07-1997	JP 6118888 A	28-04-1994
		JP 6118247 A	28-04-1994
		US 5386347 A	31-01-1995
EP 0561329 A	22-09-1993	DE 69303073 D	18-07-1996
		DE 69303073 T	10-10-1996
		US 5450292 A	12-09-1995
EP 0504910 A	23-09-1992	JP 4356015 A	09-12-1992
		DE 69226391 D	03-09-1998
		DE 69226391 T	11-02-1999
		US 5289351 A	22-02-1994